Technology Literacy: Connecting through Context, Content, and Contraption.

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Abstract

With NSF funding, we report a pilot and second experience in creating and installing a new technology literacy course. The weekly format consists of two lectures and one lab. Each week focuses on a single device which is treated three ways: **context** (survey prior technologies with similar or related purposes), **content** (explain the modern technology), and **contraption** (visit lab, use and take apart the device). The context provides indication of the historical and intellectual developments prior to the current, most modern device; the content explains the operation and principles underlying the device's performance, and the laboratory forces confrontation of device utilization and dissection with device explanation. Devices visited, one per week, in the corresponding weekly laboratory period are bar code scanner, compact disc player and burner, FAX machine, electric and acoustic guitar, electric drill, bicycle, internal combustion engine, optical fibers, photocopy and scanner, digital and video cameras, cell phones, and (model) airplanes.

Introduction

The author created, in 1992, a device dissection laboratory for incoming first year engineering students. As "It seemed desirable to base a new lab on some modern and emerging technologies"[1,2], the course was developed around six light-based devices: bar code scanner, compact disc player, optical fiber communication and probes, photocopier, video camera (and VCR recorder), and ultraviolet (UV) light driven water purification.[1,2] This inexpensive lab was assembled for less than $5,000, and has been utilized for new engineering students in the following formats over a ten year period:

(1) two week summer camp[1,2] (1993-1994) (NSF-SUCCEED)
(2) semester length "device dissection" lab[3,4] (1995-1996)
(3) in combination with an English writing course[3]
(4) (part of) summer minority eng'g. orientation (40 students)
(5) six hour/semester (1 device) experience for all 1,100 entering engineering freshmen.[5]

All student clientele for these lab versions were incoming or first year engineering students, and the switch from one lab format to another was accomplished with minimal reorganizational effort.

Expansion of the device lab concept to yet other educational possibilities was summarized in "A Lab for all Seasons, A Lab for all Reasons" (ASEE 2000, Ollis).[6] One such possibility included "Technology Literacy", a course aimed at non-technical majors. The origin of the author's efforts here is physicist John Krupczak's "Technology Literacy" course developed for students at Hope College, a small, selective admission college with a dominance of liberal arts majors[7-10]. The present author's pathway to establishing this latter course for non-technical majors at NCSU has been anything but smooth, in contrast to the earlier course incarnations of "device dissection" for technical majors cited above. Our previous 2004 ASEE paper reported the bumpy road and lessons learned while installing our technology literacy course at NCSU, in hopes that it could assist other interested faculty in initiating similar ventures. The present paper describes the process of creating the lecture and lab materials for the new technology literacy course, teaching the pilot course in fall 2004, and plans for a second semester offering in spring of 2005.Spring results will be reported at the June 2005 ASEE meeting.

Formatting the Course

In more detail, we have developed a two lecture and single lab per week format with the following characteristics:

Lecture 1: CONTEXT: define the historical origin and technical evolution of prior devices which served the same or related functions (e.g, for digital camera, survey optics, drawing, camera obscura, Daguerrotype, black and white film, Kodak and the personal (Brownie) camera, color film, Polaroid camera/film, and video camera).

Lecture 2: CONTENT: describe principles and key operations of the modern device (e.g., digital camera: optics, automatic focus, digital image function and resolution (pixels), digital image storage and retrieval, digital image printing resolution (dpi) and software editing of image).

Laboratory: CONTRAPTION: a two hour lab provides students with opportunity to use, dissect and reassemble a device at a basic level, sufficient to encounter major process paths for, e.g. flow of material (e.g., paper in FAX and photocopy), photons (bar code scanner, camera, optical fibers, FAX and photocopy), and energy (guitar, engine, bicycle), etc.

Reading and Writing: Students read one book per month and write a paper analyzing a technical topic involving development of a commercial device (first month), a technology company (second month), and a technology hero (third month). Respective reading examples are a new computer in Kidder's The Soul of a New Machine, the Edison Electric Company, and Jeff Bezos of Amazon, Inc.

Over the semester, the students thus receive a broad view through the fourteen initial lectures, akin to a typical "survey of Western literature or philosophy, etc", then a series of explanations of everyday devices in their lives, and finally a weekly "hands-on", team based opportunity to use and take-apart current technologies. Beyond this broad encounter with ten or more technologies, via context, content, and contraption, the students follow their individual interests through reading and analyzing three books which focus individually on a device, a company and a technology hero, but broadly described so as to include, again, "context, content and contraption".

This novel, multi-dimensional approach to technology literacy is a new format for delivery of this topic. As no consensus format appears to yet exist for technology literacy courses, our form provides another choice of delivery mode for this educational challenge for the general college populace with interest, but not expertise, in technology.

Defining the topics

Our Technology Literacy course for non-technical students was to be based primarily on the devices existing in our engineering device dissection laboratory. Devices visited, one per week, in the corresponding weekly laboratory period are bar code scanner, compact disc player and burner, FAX machine, electric and acoustic guitar, electric drill, bicycle, internal combustion engine, optical fibers, photocopy and scanner, digital and videocamera, cell phones, and airplanes.

The lecture topics are arranged in pairs, with a first presentation summarizing the historical evolution of preceding technologies, and the second describing a modern descendant of this evolution. An example: for electricity, the first class surveyed "Electricity to work: from Franklin to electric power", and a second lecture titled "Electric motors and drills". The complete lecture topic sequence for fall 2004 appears in Table 1 below.

Table 1:
Lecture Topics for Technology Literacy (Fall 2004)

Evolutionary Context	Modern Example
Introduction to technology	Engineering: "Design under constraints"
Fuels to work: from fire to engine	Internal combustion engine
Electricity to work: from Franklin to electric power (AC and DC)	Electric motors and drills
Exchanging electrons for information: telegraph, telephones, and cell phones	Cellular phone networks
Catching the light: Archimides to optical fibers	Optical fiber systems
Tracking materials in commerce: from barter to bar codes	Bar code systems

Producing sound: from Galileo to Grunge	Acoustic and electric guitars:
Recording images: from Niepce to digital cameras	Digital cameras
Recording sound: piano rolls to compact discs	CD "burners"
Reproducing information: from Gutenberg's press to photocopy and scanner machines	Black/white and color photocopy
Making new materials: from ceramic alchemy to semiconductor science	The integrated circuit
Computers: Eniac to Apple	Personal computers
Flight: Ancient gods to Wright brothers	Modern jets (and models)

Arranging the laboratory

In fall 2004, our pilot offering to a small group of students allowed for perfect synchrony of lecture and lab materials. In particular, each Monday was used for a two hour pair of lectures, one on context, and a second on a modern device. The Wednesday two hour lab period provided time for device use and dissection. This format worked well for the small pilot, but our spring 2005 and subsequent offerings will require independent experiences for the lecture and lab, in order to host a reasonable number of students each semester in the space available.

Exploring individual technology cases through essays

The essay assignments were designed to encourage students to follow their individual technology interests. Three papers were to be written, one per month, with a focus on a device, a person, and a company, respectively. Students were given the opportunity to choose books from our lab library of about 600 volumes. The entire book(300-600 pp) was to be read, thereby providing a complete case study of device, company or person, as appropriate. Each reading was followed by creation of a written essay in response to the criteria and questions below in Table 2(example for an important person in technology development).

The writing was evaluated by two faculty: the author-instructor (engineer), and a second, a former English instructor, Gary Weinberg, who leads our Writing Assistance Program in the NCSU College of Engineering. The students enjoyed the freedom of topic choice, and felt they learned appreciably from the written assignments. Mr. Weinberg's comments and suggestions on the written materials indicated a strong need for such formal feedback. This second disciplinary critique for the written materials will be continued, and Mr. Weinberg's participation as consultant and grader) will be more formally included in the following version of the course.

Table 2
Writing Assignments (three per semester)

Week one: Choose a book (student choice with consent of instructor, or instructor suggestion, dealing with a substantial technology advance, person, or company)

Week two: Read entire book.

Week three: Summarize the book in a single page (three paragraphs), which explain

1. What were the social and technical settings of the time ?
2. What was the particular technical challenge addressed, and why was it important ?
3. What was discovered/found, and how was it received by competitors, professionals (corporate management, etc), family, friends and society ?

Week four: In nine-ten pages, respond to the following questions:

1. What technical challenge did s/he address?
2. Why did the investigator(s) undertake the task(s) of interest ?
3. What achievement or resolution of the technical challenge was resulted?
4. What social challenges arose during the individual or team effort, and how were the social challenges resolved ? (within a corporation ? family ? society at large ? other ?)
5. What recognition, if any, did the investigator receive ?

Paper (summary plus full text) due end of week four. (repeated for weeks eight and twelve)

No universal definition of technology literacy exists, so we created one which addresses institutional and evaluation needs. First, we recall Byars' definition[12] , reproduced in Table 3.

Table 3
"Technology Literacy: A Working Definition"[12]

"The ability to understand, intelligently discuss and appropriately use concepts, procedures and terminology fundamental to the work of (and typically taken for granted by) professional engineers, scientists, and technicians; and being able to apply this ability to:

(1) critically analyze how technology, culture and environment interact and influence one another.

(2) accurately explain (in non-technical terms) scientific and mathematical principles which form the bases of important technologies

(3) describe and, when appropriate, use the design and research methods of engineers and technologists

(4) continue learning about technologies, and meaningfully participate in the evaluation and improvement of existing technologies and the creation of new technologies."[12]

Converting definition to student learning objectives

To rephrase Byars' technology literacy definition in terms more responsive to our NCSU undergraduate distribution requirements, and to provide a basis for course evaluation, the following statement appears now in our current new course description (Table 4):

Table 4
Technology Literacy: Student Learning Objectives

"Students in this course will:

(1) Develop a basic conceptual framework and vocabulary for describing the technical and historical origins of modern technological devices

(2) Explain the conceptual operating bases of current and prior technologies which address similar societal needs

(3) Use and dissect devices to develop understanding of the relationships between technical subsystems of a device (e.g., the optical, electrical, and mechanical subsystems of a facsimile (FAX) machine), and their influence on device design and operation.

(4) Develop an understanding of the impacts (technical, economic) of a device in a given context, through lecture and individual analytic written papers.

Identifying the NCSU student audience and motivation

All NCSU undergraduates must fulfill course distribution requirements for their degrees. Undergraduates in our Colleges of Humanities and Social Sciences (CHASS), Art and Design (ADN), Education, and Management are required to take a three unit course in Science, Technology, and Society (STS), selected from the Science and Technology track of the authorized STS electives. Few electives in this current list focus on explaining to non-technical majors the workings or technical origins of modern technologies; none has a laboratory component. The NCSU Undergraduate Catalog thus indicates that, when authorized, our course could help to fulfill the 3 unit STS requirement (science and technology track) for non-technical students majoring in CHASS (B.A., B.S.), Education (Business and Marketing), Technology Education, Management (Accounting, Economics), and Architecture, (Art and Design, Graphic Design, and Industrial Design). These student groups were our target audience.

To recruit these students, we first sent invitations and flyers to undergraduate advisors in the corresponding colleges, with the hope that word of mouth would provide a flow of enrolled students. No responses were received. We then placed the following advertisement in the local student newspaper, and were rewarded with interest from several students, who formed our fall 2004 student class of three.

Table 5
First Advertisement for Technology Literacy Course

NEW COURSE SPRING 2004
for students in
CHASS, ART & DESIGN and ED & PSYCH
TECHNOLOGY LITERACY
For Non-Technical Majors

Learn about the evolution and working principles of your favorite device: electric and acoustic guitar, CD and DVD "burners", bar code scanners, photocopy machines, digital cameras, optical fiber communications, Internet, engines, computers, and water purifiers (3 units) Open: soph, jr, & sr TRACS LISTING: ECE 292T 001 SPTP-TECH NON-MAJR call no: 334580 M W 0130-0220 PM Instructor: D. F. Ollis (TWO-HOUR DEMO LAB, WED 2:30-4:30) QUESTIONS call 5-2329

Spring 2005 needed a more substantial enrollment, so we borrowed the phrase "How Stuff Works" from the related titles of several books and the name of the website created by Marshal Brain: "HowStuffWorks.com." The opening form of the new student paper advertisement read as follows:

Table 6
Revised Advertisement

NEW COURSE SPRING 2004
for students in
CHASS, ART & DESIGN and ED & PSYCH
How Stuff Works
For Non-Technical Majors

The change in language, from the accurate but vaguely remedial title of "Technology Literacy" to the more colloquial, and recognizable, "How Stuff Works" struck a responsive note. Eighteen students quickly enrolled during the normal registration period. We will continue to use this student newspaper avenue of course advertisement, given that we succeeded here and identified no other productive path to enrollment success. The latter may change when the course is included in the allowable list of electives which satisfy the STS distribution requirement for non-technical majors. Examples from technology literacy instructors at other schools, e.g. John Krupczak (Hope College) and David Billington (Princeton University) have shown this latter path to be very successful for producing good enrollments..

What did the students learn ?

Evaluation and assessment with the very small set of three students in Fall 2004 was positive but not statistically meaningful. An exit interview meeting was held, in which each area (survey lecture, device lecture, device dissection laboratory, and written papers) of the course was reviewed, and summary notes of the conversations were taken by the instructor (Ollis) In consultation with assessment expert Dr. Rebecca Brent (Education Design, Cary, NC) and Professor John Krupczak (Hope College technology literacy instructor), these results will be used to create a formal assessment form and interviews for the spring 2005 class of eighteen students.

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Biographical Information

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